

Challenges and Successes on the Path  
toward a Solar-Powered Community

# Solar in Action



## Denver, Colorado

Includes case studies on:

- Developing Creative Financing for Municipal Installations
- Integrating Solar into City Planning and Zoning
- Supporting State-Level Legislation for Solar Financing
- Supporting Boulder County's Zero-Energy Affordable Housing Project
- Engaging Solar Industry on Local Market Development Needs



Denver promotes solar in the community through highly visible installations, such as this 2-MW PV system at Denver International Airport. *Photo from Denver International Airport, NREL/PIX 18042*

*Cover photos from iStock/14933255, Denver skyline*

## About the U.S. Department of Energy's Solar America Communities program:

The U.S. Department of Energy (DOE) designated 13 Solar America Cities in 2007 and an additional 12 cities in 2008 to develop comprehensive approaches to urban solar energy use that can serve as a model for cities around the nation. DOE recognized that cities, as centers of population and electricity loads, have an important role to play in accelerating solar energy adoption. As a result of widespread success in the 25 Solar America Cities, DOE expanded the program in 2010 by launching a national outreach effort, the Solar America Communities Outreach Partnership. As the Solar America Cities program evolved to include this new outreach effort, the program was renamed Solar America Communities to reflect DOE's commitment to supporting solar initiatives in all types of local jurisdictions, including cities and counties. Visit Solar America Communities online at [www.solaramericacommunities.energy.gov](http://www.solaramericacommunities.energy.gov).

# Denver's Starting Point

Denver was designated by the U.S. Department of Energy (DOE) on March 28, 2008, as a Solar America City. As the largest city in a state with progressive government programs and the fifth best solar potential in the nation, Denver was uniquely positioned to become a leader in the burgeoning solar movement. At the time, Denver's solar resources and activities were as follows:

- The city had an installed photovoltaic (PV) capacity of less than 1 megawatt (MW).
- Denver had begun to implement an ambitious solar program for city facilities as part of the 2006 Greenprint Denver Action Agenda, a comprehensive plan for sustainable development.
- The State of Colorado passed Amendment 37 and House Bill 1281 legislation, which, at the time, increased the Renewable Portfolio Standard (RPS) for Colorado to 20% by 2020.
- Colorado's RPS and significant utility rebates created a market that led to dramatic growth in the solar industry.

## Building Partnerships and Setting Goals

The Solar America Cities award in 2008 jump-started Denver's solar program. The city already had developed a sustainability office called Greenprint Denver, an initiative to integrate environmental impact considerations into the city's programs and policies. Denver intended to capitalize on Colorado's progressive government programs and tremendous solar potential to change the city's energy market by establishing solar as a mainstream energy resource option. Working with its partners, the city developed the following goals for its solar program:

1. Create an implementation plan to determine how municipal government can promote and remove barriers to solar installations in residential, commercial, and government sectors.
2. Support the creation of new job opportunities in the solar energy industry for Metro Denver residents to meet the expected increase in demand.
3. Educate the general public, perform public outreach, and develop website materials that would increase public awareness regarding the benefits of solar energy.

4. Make solar energy a significant element in meeting Greenprint Denver goals.

Project partners include:

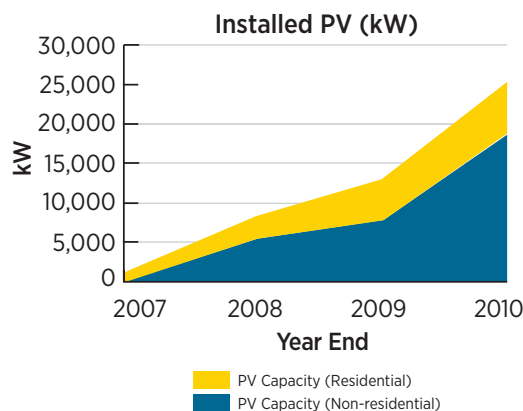
- Boulder County
- City of Aurora
- City of Boulder
- Colorado Renewable Energy Society
- Governor's Energy Office
- Lowry Energy Initiative
- Metro Mayors Caucus
- Smart Energy Living Alliance
- Xcel Energy

After being designated a Solar America City, Denver worked with its partners to develop a solar implementation plan. The following were identified as key initial activities to meet the city's solar goals:

- Develop a low-interest solar loan program to make solar installations more affordable for the public.
- Conduct beginning outreach activities to educate area residents about programs developed as a result of this project, as well as existing solar opportunities. As part of this activity, the city developed a scope of work with the

## Installed Capacity

Denver



Installed PV capacity increase from December 31, 2007, to December 31, 2010

Smart Energy Living Alliance (SELA) to provide public solar outreach and education services.

- Produce a Solar Master Plan to identify Denver's solar capacity and prioritize solar installations for city facilities.
- Review the Denver zoning code to minimize negative impacts on solar accessibility.
- Include solar language in the Better Denver bond project criteria.



The 300-kW PV system at the Denver Convention Center was one of the first large-scale solar projects on a city-owned facility. This system serves as a visible reminder of the city's commitment to solar for millions of visitors to the center annually. *Photo from Namaste Solar Electric, NREL/PIX 18044*





This PV array has 465 solar panels split between roofs on the southeast and southwest wings of the Denver Museum of Nature and Science. The installation was made possible through a collaboration of Hybrid Energy Group, Partnership for Sustainability, Xcel Energy, and Namaste Solar Electric. *Photo from Denver Museum of Nature and Science, NREL/PIX 18045*

## Accomplishments and Highlights

Denver focused its energy across many aspects of the solar industry, including participating in legislative activities, conducting face-to-face public outreach, and working to change city code to remove barriers to solar technology implementation. Highlights of Denver's accomplishments include the following:

- A total increase to nearly 10 MW of cumulative capacity for PV systems installed on city facilities
- Integration of solar considerations into city planning, including construction of new city facilities, as well as into the city's revised zoning code
- Support of many successful state legislative activities, including an increase of the RPS to 30% by 2020; a statewide Community Solar Gardens program; and allowing third-party ownership of residential PV systems.

Denver focused on getting solar technologies considered for all new city construction.

## Case Studies: Successes and Challenges

### Developing Creative Financing for Municipal Installations

The City of Denver has aggressively pursued the implementation of PV systems on city government buildings.

It has used creative financing, such as New Market Tax Credits and Power Purchase Agreements (PPAs), to fund these efforts. By finding a developer able to layer a traditional PPA with New Market Tax Credits available for projects in low-income census tracts, the developer's cost of capital was reduced, and those savings were passed on to the city. Using these financing strategies, Denver was able to secure a 1-MW PPA for installations at 13 city buildings at prices significantly below the cost of traditional electricity from the grid.

The Colorado Convention Center's 300-kW rooftop PV system came online in early 2009. An interactive educational display of the system was developed for those who visit the Denver facility. Soon after, construction was completed on the first phase of a joint partnership with Denver Public Schools (DPS). Denver and DPS issued a joint Request for Proposals (RFP), worked together on vendor selection, and collaborated on contract negotiations to find economies of scale and reduce administrative costs. DPS is planning to install a cumulative total of 2.9 MW on 26 school buildings by the end of 2011.

Denver International Airport (DIA), a city facility, also announced that a new 4.5-MW PV system will be installed in 2011. This will bring DIA's total to more than 8 MW, after a new 1.6-MW PV facility at the airport's fuel farm opened in early 2010, and a 2-MW, single-axis tracking system near the airport entrance opened in 2008. Two of the systems used a unique financing structure in which the airport provided a low-interest loan to the developer to reduce the cost of the PPA.

### Integrating Solar into City Planning and Zoning

The city took a series of actions throughout its own governing body to foster solar technology implementation and to remove barriers to its adoption.

Early on, the Denver team focused on getting solar technologies considered for all new city construction. For example, through the Better Denver Sustainability Committee, Denver is now evaluating each project developed for the city for potential inclusion of solar technologies, including all construction under the city's new \$550-million infrastructure bond program.

Next, Denver streamlined the solar inspection process to allow PV systems to be viewed as complete electrical systems rather than inspecting each of the individual electrical components.

Today Denver only verifies the PV system design to ensure the connection points to the grid, which requires a shutoff switch between the panels and the inverter, and another between the inverter and the meter, rather than reviewing all the electrical connections between panels.

In addition, as a part of the city's effort to rewrite its 60-year-old zoning code, it conducted a solar access analysis to determine if code changes might adversely affect PV systems through the creation of shading barriers. Several rounds of modeling have demonstrated that no negative impact will result from the new code changes. The results revealed a minor decrease in average solar access (roughly one half-hour per day) at maximum build out of the new code. Revisions between drafts, including eliminating gables on the north end of properties and reducing north wall heights, were added to produce solar access improvements before the code was finalized.

Finally, the team developed a Solar Master Plan Denver, which includes information about the solar potential and costs of solar PV and solar hot water at municipal facilities across the city. Information on electric and natural gas use was collected for each building, and roof inspections were conducted to determine the solar potential for each rooftop.

## Supporting State-Level Legislation for Solar Financing

The Denver team participated in a variety of state-level legislative activities that enhanced the city's efforts to increase solar adoption.

HB10-1328, Colorado's New Energy Jobs Creation Act, creates a 'property-assessed clean energy' (PACE) program across Colorado to finance up to \$800 million in solar thermal, solar electric, and other renewable energy and energy efficiency improvements for residential properties in participating counties where the new energy improvement district has been authorized. Unfortunately, federal regulatory uncertainty surrounding PACE financing programs has left the outcome of HB10-1328 in limbo. The national discussions related to PACE financing has forced Boulder County to put the residential component of its successful ClimateSmart Loan Program on hold. Denver continues to monitor the issue, and plans to evaluate the financial implications of participation in statewide and multicounty PACE districts (authorized by HB10-1328 and SB10-100, respectively).

On the positive side, program development continues on HB10-1342, which authorized Community Solar Gardens in



The Denver team participated in a variety of state-level legislative activities that enhanced the city's efforts to increase solar adoption. *Photo from Warren Gretz, NREL/PIX 06202*

Colorado, a Solar Shares program that will allow residents without sufficient solar access on their own property, or those who do not own property, to purchase shares in an offsite solar installation that will be allocated to their utility bills.

One of the biggest challenges for solar financing was Colorado Public Utilities Commission (CPUC) rules governing Xcel Energy's Solar\*Rewards program. The program offers rebates with the purpose of reducing the costs of solar installations. Written without PPAs in mind, CPUC rules required cities to take on the full repayment liability, which would need to be appropriated rather than passed on to the developer. Denver took the lead and worked with Xcel and the commission to let governments assign rights and liabilities associated with solar rebates to solar developers. Government entities across Colorado can now take full advantage of the financial incentives of PPAs and more easily participate in the Solar\*Rewards program.

## Supporting Boulder County's Zero-Energy Affordable Housing Project

Denver's technical assistance team at the National Renewable Energy Laboratory (NREL) completed a report for Colorado Housing Authorities to determine the potential of installing solar in affordable housing developments. The findings of this report for implementing a 153-unit net zero-energy residential housing development in Lafayette, CO, were adopted by the Boulder County Housing Authority (BCHA) and its project partners.

NREL staff helped BCHA design three prototype homes in 2008 using modular systems-built construction. The primary goal of the project was to test a number of high-performance

building systems, renewable energy systems, and systems-built assembly methods to develop a replicable model for affordable net zero-energy residential housing at a total construction cost under \$115 per square foot.

With the inclusion of a 4- to 5-kW, roof-mounted PV system, the homes achieve net zero energy over the course of a year.

## Engaging Solar Industry on Local Market Development Needs

Denver commissioned a “Solar Market Analysis” report to assess the participation of existing Denver area businesses in the solar industry supply chain, and identify challenges and barriers to expanding participation. The report was developed from a survey of local installers and other solar stakeholders, and provided recommendations for city support.

The solar industry sectors that were contacted in this evaluation included technology manufacturing, installation, integrators, and service providers. This work is a continuation of the “Green Collar Jobs in the U.S. and Colorado—Economic Drivers for the 21st Century” report developed by the American Solar Energy Society and Management Information Services, Inc. in January 2009.

The results of the analysis showed that Denver was already well ahead of other similar municipalities in reducing barriers to solar. Specifically, the following percent of respondents identified solar market barriers as follows: 65% identified state or city regulations and fees; 65% cited lack of customers; 51% identified lack of knowledge of solar energy benefits; 41% mentioned building inspectors; 38% identified lack of financing; 32% were concerned about costs; 24% identified the utility solar rebate program; 22% expressed concern over “excessive” competition, unqualified installations, and shoddy workmanship; and 22% complained about utility company resistance, misinformation, or conflict of interest. The results of this analysis will be used to implement change in city policies and guide outreach activities.

Denver has increased the profile of solar from a luxury to an important means of reaching environmental sustainability goals.

## Top Takeaways

- Between the negative impact of national issues on development of a local PACE program, and the positive impact of state legislation to promote the solar industry in Colorado, Denver has learned the importance of working with external partners on issues that will support the solar industry.
- Denver had limited experience in negotiating PPAs prior to the Solar America Cities award—the complexity of the agreements and local conditions, such as balanced-budget legislation and utilities commission rules, require careful understanding before initiating new solar projects.
- Denver discovered the importance of external pricing factors on the emergence of the solar market. Denver’s relatively low electricity prices, lack of time-of-day/tiered pricing, and rapidly declining local incentives created particular burdens to project completion, despite efforts to increase the viability of solar.
- The economic recession created particular challenges to promoting solar. While earlier projects could be justified on Net Present Value grounds, declining

municipal and individual budgets made immediate cost-neutrality a priority. In other words, budget considerations now require solar installations to be cash-positive in year one, not just over the 20-year term. Use of creative financing approaches and third-party ownership models make projects feasible.

## Next Steps

Denver continues to push for solar adoption on many fronts. Some activities underway include the following:

- Denver has been working with the Denver Museum of Nature and Science to host energy efficiency and solar energy outreach events at the museum. By tapping into the museum’s members and visitors, the city expects to identify a segment of residents with particular interest and enthusiasm for solar energy.
- The city is adding more solar content to the Greenprint Denver website, with the goal of providing relevant,

appropriate, and understandable information about the benefits of solar technology and the industry.

- To promote residential solar development in lieu of a PACE-style program, Denver is working to leverage additional DOE programs to find other financing solutions that can support solar installations.
- The city is contracting with a vendor who will provide the system for the Solar Lights project for the city. Solar Lights is an art project, that uses PV and multi-media technologies, to educate and promote solar to the public.
- The city has initiated discussion with the Metro Mayor's Caucus about expanding educational information for local governments on municipal solar projects.
- PV permits will be the first permit category of Denver's online permitting system to be rolled out in 2011.

## Additional Resources

- Greenprint Denver solar website:  
[www.greenprintdenver.org/energy-emissions/solar/](http://www.greenprintdenver.org/energy-emissions/solar/)
- City of Aurora Planning and Development Service website: [www.auroragov.org/AuroraGov/Departments/PlanningAndDevelopmentServices/ComprehensivePlanningDivision/EnvironmentalManagement/Rebates/433740?ssSourceNodeId=1904&ssSourceSiteId=621](http://www.auroragov.org/AuroraGov/Departments/PlanningAndDevelopmentServices/ComprehensivePlanningDivision/EnvironmentalManagement/Rebates/433740?ssSourceNodeId=1904&ssSourceSiteId=621)

### For more city information, contact:

Scott Morrissey, Greenprint Denver Deputy Director Email: [Scott.Morrissey@denvergov.org](mailto:Scott.Morrissey@denvergov.org) Telephone: 720-865-9047

For more information on going solar in your community, visit *Solar Powering Your Community: A Guide for Local Governments* at [http://solaramericacommunities.energy.gov/resources/guide\\_for\\_local\\_governments/](http://solaramericacommunities.energy.gov/resources/guide_for_local_governments/)

For more information on individual cities' solar activities, visit [www.solaramericacommunities.energy.gov/solaramericacities/action\\_areas/](http://www.solaramericacommunities.energy.gov/solaramericacities/action_areas/)



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**Clockwise from top left:** Photovoltaic system in Philadelphia Center City district (photo from Mercury Solar Solutions); rooftop solar electric system at sunset (photo from SunPower, NREL/PIX 15279); Premier Homes development with building-integrated PV roofing, near Sacramento (photo from Premier Homes, NREL/PIX 15610); PV on Calvin L. Rampton Salt Palace Convention Center in Salt Lake City (photo from Utah Clean Energy); PV on the Denver Museum of Nature and Science (photo from Denver Museum of Nature & Science); and solar parking structure system at the Cal Expo in Sacramento, California (photo from Kyocera Solar, NREL/PIX 09435)

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